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Published:

- with international search report (Art. 21(3))
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))

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1 November 2012

(54) Title: YELLOW-GREEN TO YELLOW-EMITTING PHOSPHORS BASED ON HALOGENATED-ALUMINATES

(57) Abstract: Yellow-green and yellow-emitting aluminate based phosphors for use in white LEDs, general lighting, and LED and backlighting displays. The cerium-activated, yellow-green to yellow-emitting aluminate phosphor comprises the rare earth lutetium, at least one alkaline earth metal, aluminum, oxygen, at least one halogen, and at least one rare earth element other than lutetium, wherein the phosphor is configured to absorb excitation radiation having a wavelength ranging from about 380 nm to about 480 nm, and to emit light having a peak emission wavelength ranging from about 550 nm to about 600 nm.



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 12/28338

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - C09K 11/77 (2012.01)

USPC - 252/301.4R; 252/301.16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8)- C09K 11/77 (2012.01);

USPC- 252/301.4R; 252/301.16

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

USPC- 252/301.6P, 301.4P, 304.4H; 313/483, 486, 503, 504, 506; 257/79, 86;

Patents and NPL (classification, keyword; search terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PubWest (US Pat, PgPub, EPO, JPO), GoogleScholar (PL, NPL), FreePatentsOnline (US Pat, PgPub, EPO, JPO, WIPO, NPL);

Search terms used: lutetium, Lu, cerium, Ce, activate, alkaline, earth, metal, Al, aluminum, aluminium, halogen, halide, yellow, phosphor, Gd, Ba, Sr, F

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2004/0000862 A1 (SETLUR et al.) 01 January 2004 (01.01.2004), para [0007], [0019]-[0026]	1-3
Y	US 2010/0085728 A1 (SETO et al.) 08 April 2010 (08.04.2010), para [0087], [0097], [0134], [0144], [0183], [0197], [0208], [0253], [0256], [0407], [0442], [0444], [0544], [0552], [0553], [0564], [0572], [0590], [0596], [0597], [0600], [0697]	1-3
Y	US 2009/0212314 A1 (IM et al.) 27 August 2009 (27.08.2009), para [0013]-[0142]	1-3
Y	US 2008/0231171 A1 (SCHMIDT et al.) 25 September 2008 (25.09.2008), para [0016]-[0144]	1-3
Y	US 2008/0018235 A1 (WANG et al.) 24 January 2008 (24.01.2008), para [0016]-[0108]	1-3
A	US 2004/0256974 A1 (MUELLER-MACH et al.) 23 December 2004 (23.12.2004)	1-3
A	US 2006/0158097 A1 (JUESTEL et al.) 20 July 2006 (20.07.2006)	1-3

☐ Further documents are listed in the continuation of Box C.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

21 June 2012 (21.06.2012)

Date of mailing of the international search report

23 AUG 2012

Name and mailing address of the ISA/US

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 12/28338

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

The following claim groups were found:

Group I: Claims 1-3
Group II: Claims 4-8
Group III: Claims 9-12
Group IV: Claims 13-17

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

-- Please see Extra Sheet --

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-3

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 12/28338

Continued from Box No. III -- Observations where unity of invention is lacking:

Group I: is drawn to a cerium-activated, yellow-green to yellow-emitting aluminate phosphor comprising the rare earth lutetium, at least one alkaline earth metal, aluminum, oxygen, at least one halogen, and at least one rare earth element other than lutetium, wherein the phosphor is configured to absorb excitation radiation having a wavelength ranging from about 380 nm to about 480 nm, and to emit light having a peak emission wavelength ranging from about 550 nm to about 600 nm.

Group II: is drawn to a yellow-green to yellow-emitting aluminate phosphor comprising a halogenated aluminate, an M1+X1 additive, and a cerium activator; where M2+ is a divalent, alkaline earth metal selected from the group consisting of Mg, Sr, Ca, and Ba; X is a halogen selected from the group consisting of F, Cl, Br, and I; and wherein the M1+X1 additive is included in the phosphor in amounts ranging up to about wt%, endpoint inclusive.

Group III: is drawn to a yellow-green to yellow-emitting halogenated aluminate phosphor having the formula: $(Lu)_x(A)_{1-x}Ce_y(B)_zAl_2O_3$; where A is at least one of Sc, La, Gd, and Tb; B is at least one of Mg, Sr, Ca, and Ba; C is at least one of F, Cl, Br, and I; $0 < x \leq 0.5$; $0.001 \leq y \leq 0.2$; and $0.001 \leq z \leq 0.5$.

Group IV: is drawn to a white LED comprising: a radiation source configured to provide radiation having a wavelength greater than about 280 nm; a cerium-activated, yellow-green to yellow-emitting aluminate phosphor comprising the rare earth lutetium, at least one alkaline earth metal, aluminum, oxygen, at least one halogen, and at least one rare earth element other than lutetium, wherein the phosphor is configured to absorb excitation radiation having a wavelength ranging from about 380 nm to about 480 nm, and to emit light having a peak emission wavelength ranging from about 550 nm to about 600 nm; and at least one of a red-emitting phosphor or a yellow-emitting phosphor.

The inventions listed in the above-mentioned groups do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

Groups I-IV lack unity of invention, because even though the inventions of these groups require the technical features of a yellow-green to yellow-emitting aluminate phosphor, comprising cerium, rare earth lutetium, at least one alkaline earth metal, aluminum, oxygen, at least one halogen, these technical features are not special technical features as they do not make a contribution over the prior art in view of US 2004/0000862 A1 to Setlur et al., which discloses a yellow-green to yellow-emitting aluminate phosphor (para [0019]) comprising cerium (para [0022]), rare earth lutetium (para [0022]), at least one alkaline earth metal (para [0022]), aluminum (para [0020]), oxygen (para [0024]), at least one halogen (para [0025]).

Groups I, II, and IV lack unity of invention, because even though the inventions of these groups require the technical feature of a cerium-activated, yellow-green to yellow-emitting aluminate phosphor, this technical feature is not a special technical feature as it does not make a contribution over the prior art in view of US 2004/0000862 A1 to Setlur et al., which discloses a cerium-activated, yellow-green to yellow-emitting aluminate phosphor (para [0022]).

Groups I and IV lack unity of invention, because even though the inventions of these groups require the technical feature of the phosphor configured to absorb excitation radiation having a wavelength ranging from about 380 nm to about 480 nm, and to emit light having a peak emission wavelength ranging from about 550 nm to about 600 nm, this technical feature is not a special technical feature as it does not make a contribution over the prior art in view of US 2004/0000862 A1 to Setlur et al., which discloses the phosphor configured to absorb excitation radiation having a wavelength ranging from about 380 nm to about 480 nm, and to emit light having a peak emission wavelength ranging from about 550 nm to about 600 nm (para [0007]).

Groups I-IV therefore lack unity under PCT Rule 13 because they do not share a same or corresponding special technical feature.